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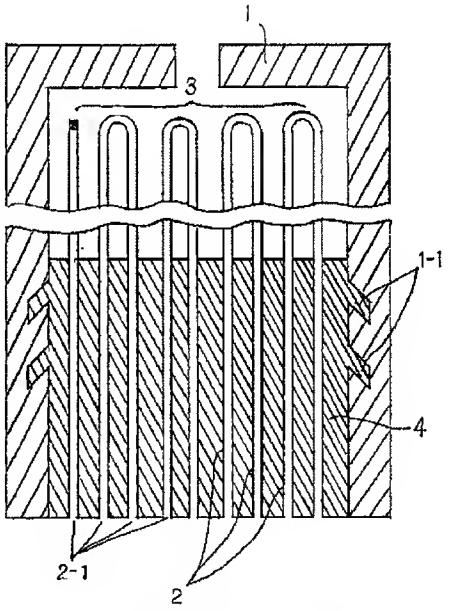
(54) [Title of the Invention] Hollow Fiber Membrane Module

57) [Abstract]

[Purpose] To provide a hollow-fiber membrane module especially suitable for a large module by using a casting resin for sealing purposes which has not been used before in a large module with a large-diameter case because the resin has a high degree of curing shrinkage despite a seal structure with excellent heat cycle properties and excellent heat and chemical resistance.

[Constitution] The hollow-fiber membrane bundle serving as the bundle of the hollow fiber membranes with fine communicating pores on the inside and outside is placed inside a case with a plurality of horizontal grooves formed in the surface of the inner wall at the end and inclined toward the end of the case depthwise, the lower bundle end being secured and sealed using a casting resin, and the lower end of the hollow fiber membrane bundle being severed to form fibers with open ends. The angle of the grooves relative to the center line of the case is between 3° and 85°, the groove width is between 0.5 and 100 mm, and the groove depth is between 0.5 and 30 mm.



1 ... Case, 1-1 ... Grooves, 2 ... Hollow Fiber Membranes

[Claim(s)]

[Claim 1] A hollow fiber membrane module having a hollow fiber membrane bundle comprising a plurality of hollow fiber membranes housed inside a case and having the open ends of the hollow fiber membranes fixed and sealed to the end of the case using a casting resin, the hollow fiber membrane module characterized in that one or more grooves are formed continuously or intermittently at a predetermined depth in the surface of the inner wall at the end of the case, and in that the grooves are inclined relative to the center line of the case at an angle between 3° and 85°.

[Detailed Description of the Invention]

[0001]

[Field of Industrial Application] The present invention relates to a hollow fiber membrane filter module used for high-temperature sterilization and hot water filtration in which filtration is performed using hollow fiber membranes during extreme temperature fluctuations. More specifically, the present invention relates to a filtration module with a large diameter module case, that is, a large hollow fiber filtration module.

[0002]

[Prior Art] When hollow fiber membranes are made into a module, a hollow fiber membrane bundle consisting of a plurality of hollow fiber membranes is usually packed into a module with the open ends of the hollow fiber membranes aligned. A liquid thermosetting resin is then injected between the open ends of the hollow fiber membrane bundle and the ends are fixed and sealed.

[0003]

[Problem(s) Resolved by the Invention] However, because the liquid casting resin used for sealing purposes and the case are made of different materials, the materials come under strain during filtration performed with extreme temperature fluctuations due to the difference in thermal expansion coefficients. In a large module in which the case has large dimensions, peeling occurs due to the heat cycle, the sealing resin becomes cracked, and overall durability is insufficient. As a result, the module can only be used at room temperature ± 20°C. When a module is created, the liquid casting resin used for sealing purposes has to experience very little curing shrinkage. However, there are limits on the outer diameter of the module case even when a liquid casting resin with very little curing shrinkage is used.

[0004] The purpose of the present invention is to provide a hollow-fiber membrane module especially suitable for a large module by using a casting resin for sealing purposes which has not been used before in a large module with a large-diameter case because the resin has a high degree of curing shrinkage despite a seal structure with excellent heat cycle properties and excellent heat and chemical resistance.

[0005]

[Means of Resolving the Problem(s)] As a result of extensive research to achieve this purpose, the present inventors discovered the effectiveness of creating grooves in the surface of the inner wall of the case at a predetermined angle depthwise. The present invention is a product of this discovery.

[0006] In other words, the present invention is a hollow fiber membrane module having a hollow fiber membrane bundle comprising a plurality of hollow fiber membranes housed inside a case and having the open ends of the hollow fiber membranes fixed and sealed to the end of the case using a casting resin, the hollow fiber membrane module characterized in that one or more grooves are formed continuously or intermittently at a predetermined depth in the surface of the inner wall at the end of the case, and in that the grooves are inclined relative to the center line of the case at an angle between 3° and 85°.

[0007] There are no particular restrictions on the form of the grooves. The grooves can be continuously or intermittently horizontal. In addition to being horizontal, they can also have a zigzag pattern. These grooves can be formed alone or in combinations of two or more in one or two stages.

[0008] In the present invention, the grooves have to be inclined depthwise at a predetermined angle. In other words, the grooves have to be inclined relative to the center line of the case at an angle between 3° and 85°. If the angle is less than 3°, the sealing resin tends to crack at the openings in the grooves. If the angle is greater than 85°, the resin tends to peel. In the present invention, the depth of the grooves perpendicular to the center line is preferably between 0.5 and 30 mm, and the width of the grooves is preferably between 0.5 and 100 mm.

[0009]

[Operation] Because the casting resin used to seal the hollow fiber membranes is bonded and integrated inside the grooves, the casting resin is bonded to the inner surface of the case in step-like fashion. Because the bonding area is increased and the peeling direction is not constant, resistance to peeling is actually increased. Resistance to the heat cycle and to pressure inside the case is also improved. By limiting the direction of the grooves depthwise in the manner described above, the resistance of the casting resin to hydraulic pressure inside the case is improved while leaking at the interface with the case is eliminated.

[0010]

[Working Example(s)] The following is an explanation of working examples of the present invention. The figures show simplified configurational examples of the hollow fiber membrane module of the present invention. FIG 1 is a vertical cross-sectional view in which a portion of the hollow fiber membrane module of the present invention has been omitted, and FIG 2 is an enlarged view of the same portion of the module.

[0011] In this module example, hollow fiber membranes 2 with fine pores communicating on the inside and outside are folded over at a predetermined length, and the resulting hollow fiber membrane bundle 3 aligned at both ends is housed inside a case 1. The lower bundle end is fixed and sealed using a casting resin 4, and the lower end of the hollow fiber membrane bundle 3 is cut to form open ends 2-1 in each fiber. One or more grooves 1-1 is formed in the surface of the inner wall at the lower end of the case 1 inclined downward depthwise as shown in FIG 2, and the casting resin is injected into the grooves. The width of the grooves 1-1 is between 0.5 and 100 mm, the depth perpendicular to the wall surface is between 0.5 and 30 mm, and the angle of inclination relative to the center line of the case 1 is between 3° and 85°.

[0012] FIG 3 shows another hollow fiber membrane module of the present invention. In this module example, an injection port is formed in the middle of one side of the case, and the casting resin is used to seal both ends of the hollow fiber membrane bundle 3. Here, grooves 1-1 are formed at both ends of the case 1, and the grooves are inclined depthwise towards the ends.

[0013] The following is a more detailed explanation of the present invention with reference to a comparative example and to specific examples using the module shown in FIG 3.

[0014] (Specific Example 1) The porous polyethylene hollow fiber membrane bundle had a groove width of 3 mm and a groove depth of 5 mm. This was inserted into a polycarbonate case with an inner diameter of 120 mm, an outer diameter of 140 mm, a length of 80 mm, and continuously horizontal grooves angled at 45° relative to the center line of the case formed in five stages in the surface of the inner wall at both ends. An epoxy casting resin was injected between the hollow fiber membranes at the bottom end. After curing, the end of the hollow fiber membrane bundle was cut. The opposite end was bonded and cut in the same manner.

[0015] A heat cycle test was performed in which a single cycle consisted of passing 80°C hot water through the module for 10 minutes, followed by passing 15°C water through the module for 10 minutes.

[0016] Even after 500 cycles, there was no epoxy resin cracking and no leakage from the seal. After sterilizing the module for 30 minutes at 121°C with steam, a heat cycle test was performed in which a single cycle consisted of passing 15°C water through the module for ten minutes. After 100 cycles, there was no epoxy resin cracking and no leakage from the seal. A pressure impact test was then performed on the module in which a single cycle consisted of filtering 80°C water for 10 seconds at 5 kg/cm^2 of water pressure, maintaining 0 kg/cm^2 of water pressure for 10 seconds, and again filtering 80°C water for 10 seconds at 5 kg/cm^2 of water pressure. After 20,000 cycles, there was no epoxy resin cracking and no leakage from the seal.

[0017] (Specific Example 2) A module was prepared in the same manner as Specific Example 1 except that the five grooves were reduced to one. When the heat cycle tests and the pressure impact test were performed on the module in the same manner as Specific Example 1, there was no epoxy resin cracking and no leakage from the seal.

[0018] (Comparative Example) A module was prepared in the same manner as Specific Example 1 except that no grooves were formed in the polycarbonate module case. The heat cycle tests were performed in the same manner as Specific Example 1. Initially, there was no leakage. However, a leak occurred between the epoxy resin and the module case after ten cycles. The pressure impact test was performed in the same manner as the specific examples. Initially, there was no leakage. However, a leak occurred between the epoxy resin and the module case after 1,100 cycles.

[0019]

[Effect(s) of the Invention] In the configuration of the present invention, as explained above, filtration can be performed by hollow fiber membranes in a large module with a large-diameter case under conditions with extreme temperature fluctuations.

[Brief Explanation of the Figure(s)]

[FIG 1] A vertical cross-sectional view in which a portion of the hollow fiber membrane module of the present invention has been omitted.

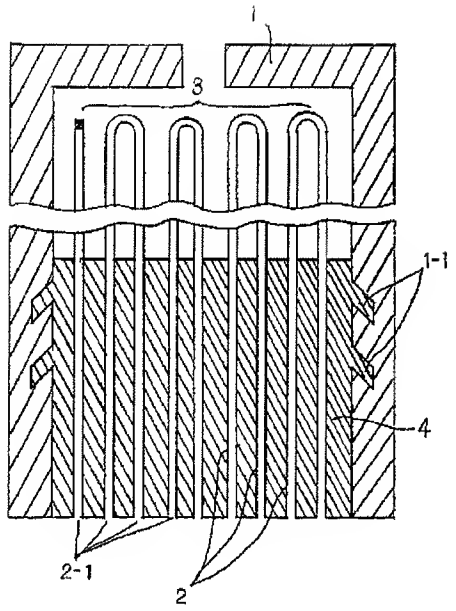
[FIG 2] An enlarged view of the same portion of the module.

[FIG 3] A vertical cross-sectional view in which a portion of another example of a hollow fiber membrane module of the present invention has been omitted.

[Key to the Figure(s)]

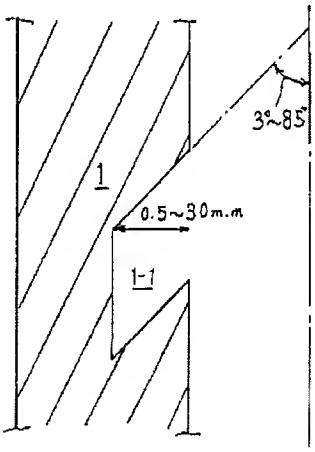
1	Case
1-1	Groove
2	Hollow Fiber Membrane
2-1	Open End
3	Hollow Fiber Membrane Bundle
4	Casting Resin

[FIG 1]



1 ... Case, 1-1 ... Grooves, 2 ... Hollow Fiber Membranes

[FIG 2]



[FIG 3]